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RESEARCH ARTICLE

COMPARISON OF THE FLORISTIC COMPOSITION OF THE BIOTOPES OF BANCO NATIONAL PARK, SOUTHERN COTE D'IVOIRE

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Abstract

This study was conducted in the Banco National Park (Abidjan, Cote d'Ivoire), one of the last remnants of dense humid forest in an urban environment in the sub-region. It is part of an effort to ecologically characterize the park's wetlands, with a view to guiding conservation and sustainable management strategies. The adopted methodology combines linear and surface floristic surveys distributed across four types of forest formations the are upland forest, swamp forest, riparian forest, and periodically flooded forest. The floristic analysis identified 161 plant species across 50 families, with a predominance of Fabaceae and Apocynaceae throughout the forest. Comparison of the habitats showed that riparian forest is the richest in species, while swamp forest and periodically flooded forest exhibit lower diversity. the endemic species in Cote d'Ivoire (GCi) and the Guineo-Congolian region (GC) within the different study areas highlights a significant difference for the GCi group. Overall, in the surveys conducted, trees are the most represented morphological types, both on dry land and in wetland areas. Regarding megaphanerophytes, the highest rate is observed in the riparian forest In this forest. the presence of species with conservation status can be observed. The significant presence of these species highlights the ecological value of these wetland environments and their crucial role in biodiversity conservation in an urban context.

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Introduction:-

In the face of this critical situation, the Ivorian state has implemented conservation policies, notably through the creation of national parks and nature reserves. These protected areas aim to preserve the remaining biodiversity, curb plant species erosion, and promote sustainable ecosystem management (Sako et al., 2014). Today, these protected areas are fundamental tools for the conservation of flora and the ecological resilience of the national territory. Among these parks, we can mention Banco National Park. This urban park plays a crucial role in the city's ecological regulation, climate effect mitigation, water purification, and flood control. However, despite these benefits, it is not free from threats and pressures, particularly facing significant anthropogenic pressure due to the rapid urbanization of the city. This pressure leads to a gradual degradation of its forest mass (N'Guessan et al.,

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2013), causing the disruption of humid areas, which are rich in floral biodiversity and provide ecosystem services, located within it. This disruption results in a reduction of floral diversity, compromising the ecological balance of these specific environments. According to Whitmore and Sayer (1992), the continued destruction of forest ecosystems is likely to lead to the extinction of a large number of plant species, sometimes before their existence is even scientifically documented. The objective of this study is to compare the wetlands that make up this forest in order to promote sustainable management of it.

Materials and Methods:-

Study Site : Banco National Park (PNB) is located in the south of Cote d'Ivoire, more precisely on the northern outskirts of the large Abidjan metropolitan area (Fig 1). It covers an area of 3,438.34 hectares . It is situated between 5° 21' and 5° 25' North latitude and 4° 01' and 4° 05' West longitude.

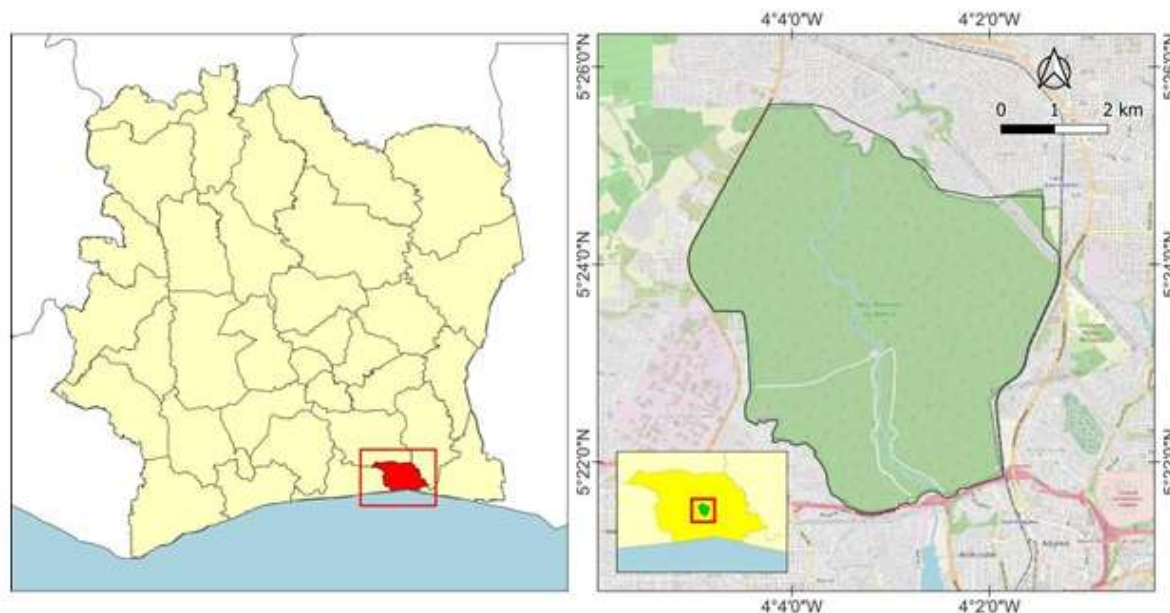


Fig 1. Location of Banco National Park

Methodology:

Field Method:-

Linear Surveys:

The linear survey method, initially described by Gautier et al. (1994), constitutes an effective approach for studying vegetation. This technique has been adopted and adapted in several studies on tropical forest ecosystems, notably by N'Guessan (2008), Kouameet al. (2015), and Soro et al. (2019). It involves laying a 200-meter-long rope horizontally on the ground (figure 4), along which surveys are conducted at regular intervals. In this study, 100 measurement points were taken every two meters using 4-meter-high stackable stakes, positioned vertically at each point. At each location, all contacts between the vegetation and the stake were recorded, with no height limit. At each location, all contacts between vegetation and the stake are recorded, with no height limit. For each point of contact between the stake and a plant species, the species is identified, and the minimum and maximum heights of its contact with the stake are noted.

Surface surveys:

The surface survey method used in this study is a traditional method that has already been used for the study of flora by numerous researchers including Devineauet al. (1984), Ahouandjinouet al. (2017) and Gueulou et al. (2018) but with different dimensions. It involves recording all the plant species present in the plots and measuring the diameter at breast height (DBH) of woody individuals. For this study, square plots of 10 meters per side, covering an area of 100 m², were established in the different studied biotopes. In each biotope, along a 200-meter line, three (3) plots were set up. Inside these plots, square subplots of 5 meters per side, covering an area of 25 m², called regeneration subplots, were established to facilitate data collection. The floristic inventory involved recording all individuals with

a diameter at breast height greater than or equal to 5 centimeters (i.e., a circumference greater than or equal to 15.70 centimeters) throughout each 100 m² plot. These various circumference measurements were recorded on field sheets.

Analysis Method:

Floristic Composition The floristic composition will consist of recording the characteristics of the flora. This notably involves specifying: the families, genera, biological types, chorological affinities, as well as species with a particular status. 3.2.4 **Biological Types** Biological types are classifications used to describe and organize the diversity of life forms and biological processes. They provide information on the type of plant formation, its origin, and its transformations (Nora et al., 2019). The main biological types considered in this study are as follows: Megaphanerophytes (MP); Chamaephytes (Ch); Lianas Microphanerophytes (Lmp); Lianas Nanophanerophytes (Lnp); Mesophanerophytes (mP); Microphanerophytes (mp); Nanophanerophytes (np); Rhizomatous Geophytes (Gr); Geophytes (G); Hydrophytes (Hyd); and Therophytes (Th).

Chorological Types :

Chorology is the explanatory study of the geographical distribution of living species and its causes. These different chorological types will be made based on the work of Ake-Assi (2001; 2002). They will be used to distinguish species according to their geographical distribution in relation to vegetation. Thus, we distinguish: Taxon of the Guineo-Congolian region (GC); Taxon of the transition zone between the Guineo-Congolian and Sudanian-Zambezian regions (GC-SZ); Introduced exotic taxon (i); Endemic to Cote d'Ivoire (GCi); Endemic species of the forest block in western Togo (GCW). 3.2.6 **Morphological Types** Taxonomists distinguish one species from another by different and stable morphological characteristics (Spichiger et al., 2002). Morphology is the form and external structure of the plant and its organs

Statistical data analysis :

Analysis of variance Analysis of variance is a technique used to compare the means of two or more populations based on samples drawn from each of them (Legendre and Legendre, 2012). For this study, one-way analysis of variance (ANOVA) was applied to compare the means of different measured variables.

Results:-

Floral richness and composition :

The compilation of all species recorded through linear and surface surveys in the four biotopes resulted in a total of 161 species. The inventory of plots in the riparian forest of the northern sector recorded 80 species distributed across 69 genera belonging to 34 families. A total of 48 species belonging to 47 genera and 24 families were recorded in the swampy area of the central sector of the park, while the periodically flooded area of the southern sector recorded 43 species spread across 39 genera and 20 families. As for the terra firme forest, 77 species are recorded, grouped into 65 genera and 34 families. Table I shows the comparison of species, genera, and families across the four biotopes. Unlike the number of species and genera, which is dominated by the riparian forest, the number of families is dominated by both the terra firme forest and the riparian forest. However, the comparison of average values of specific richness does not reveal a significant difference between the biotopes according to the ANOVA test (table I).

Table I: Comparison of counts among the different study environments

study environments						Statistical settings	
Zm			Zr	Zp	Zt	F	P
Species	Total	48	80	43	77		
	Average number	9,6 ± 1,48a	16 ± 2,12a	8,6 ± 1,08a	15,4 ± 2,08a	1,291	0,311
Genera	Total	47	69	40	67		
	Average number	9,4 ± 1,13a	13,8 ± 1,39a	8 ± 1,30a	13,4 ± 1,73a	2,942	0,0647

Famili es	Total	26	34	22	34		
	Averagenu mber	5,2 ± 1,24a	16,8 ± 1,47a	4,4 ± 0,98a	6,8 ± 1,47a	1,18	0,348

The mean values with different letters are not significantly equal at the 5% level (Tukey test).

Species with a particular status:-

The floristic analysis of the upland and wetland areas of Banco National Park made it possible to record several species with a concerning conservation status, according to Ake-Assi (2001) and the IUCN Red List (table II). These species are either rare, endemic, or threatened to various degrees (near threatened, vulnerable, or endangered). Thus, 12 species inventoried in the investigated environments have particular statuses. Among them, one species was found only in the riparian zone (*Acacia kamerunensis*) and two were found only in the swampy area (*Allanblackia parviflora* and *Anthostemmaubryanum*). In general, among the 12 species with special status in this study, 8 are found only in wetlands, while the others are present in both wetlands and upland areas.

Also, within the group of species with special status, some are classified as vulnerable or near-threatened by the IUCN. These include *Carapa procera* (VU, IUCN 2018), *Symphonia globulifera* (NT, IUCN 2020), *Hunteriaghanensis* (EN, IUCN 2021), *Laccospermasecundiflorum* (VU, IUCN 2018), and *Anthostemmaubryanum* (EN, IUCN 2017). Other species exhibit ecological rarity or a restricted geographic distribution, according to observations by Ake-Assi (2001). Examples include *Allanblackia parviflora* (rare, overexploited), *Gilbertiodendronsplendidum* (rare species of dense humid forests), *Xylopiarubescens*, and *Rinoreaoblongifolia* (rare species). This is the example of *Adenia mannii* (endemic to West Africa), *Uapaca esculenta* (strictly endemic to Cote d'Ivoire). A comparison of the endemic species in Cote d'Ivoire (GCi) and the Guineo-Congolian region (GC) within the different study areas highlights a significant difference for the GCi group (Table III).

Table II: List of species with special status in Banco National Park

Species	Status	Source
<i>Acacia kamerunensis</i>	Vulnerable (VU)	IUCN (2015) / Ake Assi (2001)
<i>Adenia mannii</i>	Endemique de l'Afrique de l'Ouest	Ake Assi (2001)
<i>Gilbertiodendronsplendidum</i>	Espèce rare (R)	Ake Assi (2001)
<i>Carapa procera</i>	Vulnerable (VU)	IUCN (2018)
<i>Symphonia globulifera</i>	Quasi menacee (NT)	IUCN (2020)
<i>Allanblackia parviflora</i>	Espèce rare (R)	Ake Assi (2001)
<i>Hunteriaghanensis</i>	En danger (EN)	IUCN (2021)
<i>Uapaca esculenta</i>	Endemique de Cote d'Ivoire (E)	Ake Assi (2001)
<i>Xylopiarubescens</i>	Rare (R)	Ake Assi (2001)
<i>Rinoreaoblongifolia</i>	Rare (R)	Ake Assi (2001)
<i>Anthostemmaubryanum</i>	En danger (EN)	IUCN (2017)
<i>Laccospermasecundiflorum</i>	Vulnerable (VU)	IUCN (2018)

Table III: Comparison of the proportions of species with GCi and GC affinities

Types chorologiques	Study environments				Statistical settings	
	Zt	Zp	Zm	Zr	F	P
GC	13,6±3,09a	7,2±0,98a	8±1,55a	13±2,60a	2,234	0,124
GCi	0,8±0,14ab	0,4±0,07a	0,5±0,07a	1±0,2b	5,143	0,0111

The mean values assigned the same letter are significantly equal.

The comparative analysis of families focuses on the most dominant groups in the four types of habitats. Regarding species richness, the results indicate that in the riparian zone, Fabaceae is the most represented with 13 species, followed by Apocynaceae with 10 species. In the swampy zone and the periodically flooded area, Fabaceae and

Apocynaceae are similar. As for the terra firme forest, the trend is relatively similar to that of the riparian zone: Fabaceae remain predominant with 11 species, followed by Apocynaceae with 4 species. The data are illustrated in the histogram of Figure 34. Comparing the different study habitats, it is observed that Fabaceae and Apocynaceae are better represented in the riparian zone. The comparison of mean species richness for the dominant families shows no significant difference ($P > 0.05$) across the different study areas, as shown in Table VII.

Table IV: Comparison of the dominant families of PNB biotopes

Families	Study environments				Statistical settings	
	Zm	Zr	Zp	Zt	F	P
Fabaceae	$2 \pm 0,40a$	$4,33 \pm 0,95a$	$2 \pm 0,23a$	$3,67 \pm 0,75a$	3,33	0,077
Apocynaceae	$1,67 \pm 0,18a$	$3,33 \pm 0,95a$	$2 \pm 0,35a$	$1,33 \pm 0,24a$	2,007	0,192

Overall, in the surveys conducted, trees are the most represented morphological types, both on dry land and in wetland areas (riparian, swampy, and periodically flooded). However, they are more dominant on dry land with a count close to 35, while their numbers gradually decrease towards the periodically flooded zone. Statistical analysis reveals no significant difference ($P > 0.05$) between the different zones in the distribution of trees, lianas, and herbaceous plants (Table V). Table VI presents the comparison of biological types of the PNB biotopes. Regarding megaphanerophytes, the highest rate is observed in the riparian forest with 7.4 ± 2.23 . For microphanerophyte lianas, the riparian forest also has the highest rate with 3.6 ± 0.96 . At the level of mesophanerophytes, dry land has the highest proportion with 4 ± 0.83 . Despite this variation, the difference between megaphanerophytes and microphanerophytes is not significant. However, the proportions of the other biological types are significantly different. Vines Herbs.

Table V: Comparison of morphological types between the different study environments

Morphological types	Study environments				Statistical settings	
	Zt	Zp	Zm	Zr	F	P
Trees	$8,5 \pm 0,92a$	$4 \pm 1,08a$	$6,5 \pm 1,27a$	$7 \pm 1,41a$	2,644	0,0969
Shrubs	$5,5 \pm 1,14b$	$1,5 \pm 0,21a$	$0,5 \pm 0,09a$	$5,5 \pm 1,24b$	9,502	0,00171
Lianas	$4 \pm 1,08a$	$3,75 \pm 0,83a$	$4 \pm 0,73a$	$6,75 \pm 1,39a$	1,902	0,183
Herbs	$1 \pm 0,34a$	$1,5 \pm 0,20a$	$1 \pm 0,34a$	$0,75 \pm 0,10a$	1,107	0,384

Table VI: Comparison of the proportions of biological types according to the study environments

Biological types	Study environments				Statistical settings	
	Zt	Zp	Zm	Zr	F	P
MP	$3 \pm 0,93a$	$1,8 \pm 0,39a$	$4,4 \pm 1,23a$	$7,4 \pm 2,23a$	3,116	0,0556
Lmp	$1,4 \pm 0,36a$	$2,4 \pm 0,35a$	$1,8 \pm 0,48a$	$3,6 \pm 0,96a$	2,601	0,088
Mp	$4 \pm 0,83b$	$1 \pm 0,2a$	$0,6 \pm 0,14a$	$1,2 \pm 0,32a$	11,3	0,000315

Discussion:-

The comparison of habitats has shown that the riparian forest has the highest floristic richness of all the surveyed areas. As indicated by our study, throughout the forest, the Fabaceae and Apocynaceae families are the dominant families. These same families are noted as species-predominant in most studies conducted in forests (Bakayoko, 2005; Amba et al., 2021). The dominance of these families could be explained by the fact that all the areas studied in the park still retain forest characteristics. The Shannon-Weaver diversity index varies from one area to another, with the highest values observed in the terra firme and riparian areas, reflecting strong species richness. Conversely, the swampy and periodically flooded areas exhibit relatively low species diversity. Conversely, the swampy and periodically flooded areas exhibit relatively low species diversity.

This low diversity, particularly in the periodically flooded zone, could be linked to habitat degradation due to anthropogenic disturbances, as suggested by Boukpeou (2013). On the other hand, Pielou's evenness indices remain high across all areas, indicating a relatively balanced distribution of individuals among species. Such a

situation may reflect low or balanced dominance among species, regardless of the level of species diversity (Mugurran, 2004). This aligns with the conclusions of Chazdon et al. (2009), who found that evenness can remain stable in slightly degraded environments, even when species richness declines. The comparison of the proportions of morphotypes reveals that the upland area hosts the highest proportion of trees and shrubs. This predominance of tree species could indicate an environment relatively preserved from human disturbances. On the other hand, lianas are particularly well represented in the riparian zone. This high proportion could result from the degradation of vegetation due to anthropogenic activities (Gautier et al., 1999). These activities promote the development of species such as lianas and heliophilous species, which are better adapted to open and disturbed environments (Schnitzer and Bongers, 2002). This would explain the high abundance of lianas observed in this area compared to others.

Conclusion:-

The vegetation of Banco National Park is structured into various plant formations. The present study, conducted within the biotopes of Banco National Park, made it possible to compare the floristic composition of the woody communities of wetland areas with those of dry land. From this comparison, it appears that BNP has a floristic richness, dominated in terms of the number of species by Fabaceae and Apocynaceae. The results obtained reveal a relatively rich flora. The riparian forest stood out for its high specific richness.

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